U.S. DEPARTMENT OF COMMERCE National Technical Information Service

AD-A034 667

UH-1H DOWNWASH VELOCITY MEASUREMENTS

ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG, MISSISSIPPI

AUGUST 1972

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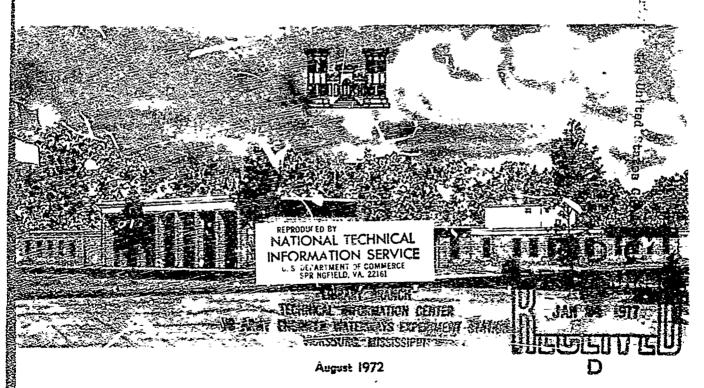


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UH-1H DOWNWASH VELOCITY MEASUREMENTS

by

G. W. Leese



Sponsore by U. S. Army Mobility Equipment Ruseerch and Development Center Fort Belvoir, Virginia

Soils and Pavements Leboratory
Vicksburg, Mississippi

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FOREWORD

Authorization for this investigation was contained in a letter dated 20 April 1972 from the U. S. Army Mobility Equipment Research and Development Center (MERDC), Ft. Belvoir, Va., subject: Intra Army Order for Reimbursable Services No. A2297.

The data reported herein were obtained during 1972 by personnel of the U. S. Army Engineer Waterways Experiment Station (WES), Soils and Pavements Laboratory under the general supervision of Messrs. J. P. Sale, R. G. Ahlvin, and W. L. McInnis, and under the direct supervision of Mr. G. W. Leese. Mr. W. J. McNamara (MERDC) prepared the plan of test and made necessary arrangements with the U. S. Army Aeromedical Laboratory, Ft. Rucker, Ala., for use of the aircraft and airfield. COL W. P. Shane, assisted by CPT G. R. McCahan, Jr., Ft. Rucker, not only made arrangements for aircraft, personnel, and equipment for this study at the airfield at Apalachicola, Fla., but assisted WES personnel in performing the tests.

COL Ernest D. Peixotto, CE, was Director during the study and preparation of this report. Mr. F. R. Brown was Technical Director.

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CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

Multiply	<u> </u>	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
pounds	0.45359237	kilograms
miles per hour	1.609344	kilometers per hour

SUMMARY

Field measurements were made to determine the velocity of the horizontal and vertical downwash flow beneath the rotor of a UH-1H helicopter.

Maximum downwash velocities measured during 7-sec periods were as follows:

	Distance from	Aircraft Hover	Position	Maximum Downwash	
Direction of Flow	Center of Rotor Rotation, ft	Height ft	Heading* deg	Velocity mph	Remarks
Horizontal	41	10	360	59	••
Vertical	29	30	270	30	6' above ground

^{*}Referenced to instrument line:

³⁶⁰⁻deg heading, aircraft facing line

²⁷⁰⁻deg heading, aircraft rotated 90 deg left

UH-1H DOWNWASH VELOCITY MEASUREMENTS

Introduction

1. The purpose of this investigation was to obtain field measurements of the horizontal and vertical downwash flow beneath the rotor of the UH-1H helicopter. These measurements were obtained by placing velocity transducers in a test area at the airfield at Apalachicola, Fla., and recording data as aircraft hovered in various positions in relation to the instruments.

Aircraft

2. The aircraft utilized in this study was the standard version of the UH-1H helicopter, which is a turbine-driven, single-rotor aircraft with a rotor diameter of 48 ft* and a gross weight of 8540 lb as tested. The distance between the aircraft skids and rotor actuator plane is 13 ft. The aircraft was equipped with a radio altimeter, which was used during these tests to maintain heights above the ground plane.

Instrumentation

3. Instrumentation consisted of velocity transducers of the voltage generation type using a 4-in.-diam propeller to sense the downwash velocity. The instruments were placed on the concrete apron of the airfield as shown in plate 1. There were six stands, each of which held six transducers. The stands were constructed so as to measure downwash velocities at heights of 2, 4, and 6 ft above the ground surface and were spaced 4 ft apart on the apron. The stands were mounted 12 deg off perpendicular in direction to the UH-1H helicopter rotation to prevent any interference among the vertical velocity transducers on the stands. Also, there were velocity transducers on the ground surface to measure ground surface; these transducers were spaced 4 ft apart, as shown in plate 1. The velocity transducers were calibrated in the WES wind tunnel just prior to and after the

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^{*} A table for converting British units of measurement to metric units is presented on page vii.

tests to ensure accurate calibrations. The outputs of the velocity transducers were recorded using an oscillograph. Photograph 1 shows a general view of the test area looking in the direction of ground-wash flow, while photograph 2 shows a close-up of the stands and the arrangement of the velocity transducers.

Test Procedures and Results

- 4. Tests were conducted to determine the velocity of the horizontal and vertical downwash from the helicopter rotor of a UH-1H helicopter hovering at skid heights of 10, 30, and 70 ft above the ground surface. The aircraft was positioned by personnel on the ground instructing the pilot as to necessary movements.
- 5. Vertical and horizontal downwash velocity measurements were made at 2, 4, and 6 ft above the ground surface at distances of 9, 13, 17, 21, 25, and 29 ft from the center of rotor rotation on the helicopter and at headings of 270, 300, 330, 360 deg. (Aircraft heading referenced to instrument line: 360-deg heading would be when the aircraft was facing the line of instruments; 330 deg when rotated 30 deg to left, etc.)

 Horizontal ground-wash measurements were made at the ground surface beneath each stand and also at distances of 0, 33, 37, 41, 45, 49, 53, 57, 61, 65, and 73 ft from the same center of rotor rotation. Simultaneous recordings were made of the output from all transducers. Data recordings were made only after the pilot indicated that the helicopter was stabilized, thus having the minimum of control input to the aircraft.
- 6. Simultaneous readings of downwash velocity with the aircraft hovering with rotor center of rotation over pickup 54 are shown in tables 1 and 2. Tables 3 and 4 give the maximum velocities attained during each test condition over a period of seven seconds. Maximum horizontal downwash velocity recorded during this time period was 59 mph at a distance of 41 ft from center of rotor rotation when the aircraft was at 10-ft hover height and 360-deg heading. Maximum vertical downwash velocity during this period was 30 mph at a vertical height of 6 ft above the ground surface and 29 ft from the center of rotor rotation when the aircraft was

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at 30-ft hover height and 270-deg heading. Comparisons of tables 1 and 2 and 3 and 4 indicate that most of the flow was in the horizontal plane. To verify this, personnel walked beneath the hovering aircraft and could feel very little downward flow; they noted that the instrument propellers measuring vertical flow were rotating very slowly or not at all.

UH-1H DOWNWASH VELOCITY STUDY SIMULTANEOUS HORIZONTAL VELOCITIES

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* See plate 1

Table 4 UH-1H DOWNWASH 'FELOCITY STUDY MAXIMJM VERTICAL VELOCITIES

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Photo 1. General view of UH-1H downwash measurements test area

Photo 2. Instrumentation for above-ground measurements

